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US ARMY ELECTRONICS COMMAND

Research and Development Technical Report
ECOM-77-2647-1

FLOATING DECK GRID MODULATOR

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November 1977

First Interim Report for Period March 1977 to June 1977

Prepared for

ECOM

US ARMY ELECTRONICS COMMAND FORT MONMOUTH, NEW JERSEY 07703

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A preliminary block diagram at the modulator has been developed. The preliminary study of the 50 kV isolation pulse transformer indicates that in order to meet stability requirements, it will be necessary to clip the oscillations on the secondary and regulate the pulse top level. Three primary drive configurations are being considered.

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ABSTRACT

A preliminary block diagram at the modulator has been developed. The preliminary study of the 50 kV isolation pulse transformer indicates that in order to meet stability requirements, it will be necessary to clip the oscillations on the secondary and regulate the pulse top level. Three primary drive configurations are being considered.

SUMMARY

The development of a documented working model of the pulse transformer grid modulator is to be accomplished in four phases; the transformer design, the transformer driver design, the pulse top regulator design and the construction of the model. The basic configuration has been determined and the design requirements and performance characteristics defined.

PROGRAM OBJECTIVE

This program effort is intended to develop a documented working model of a pulse transformer type TWT grid modulator (See Figure 1). This particular configuration has been chosen in order to minimize the amount of circuitry at the TWT cathode potential, and thus enhances reliability and maintainability. The pulse transformer secondary will drive the TWT grid directly while referenced to the -50 kV TWT cathode potential. The primary of the transformer is to be driven by solid state circuitry operating at potentials ranging from 200 to 400 volts with respect to chassis ground. The secondary output is to be a 2 kV pulse to modulate the grid of a high powered TWT.

PROGRAM ORGANIZATION

The design portion of the program is to be accomplished in three separate phases corresponding to the three major design problems associated with a modulator of this type.

1. The transformer must be able to withstand a secondary to primary voltage stress of -50 kV and simultaneously exhibit a primary leakage inductance low enough to allow a secondary pulse rise time of 1 usec maximum.

2. The primary drive transistors must be designed to operate at very high peak power dissipations at high temperatures without failures due to secondary breakdown. The primary drive circuitry must operate with current rise and fall times <0.5 μsec to charge and discharge the circuit stray capacity.

3. Since the pulse transformer must be under damped to provide the short rise and fall times required, it will exhibit overshoot and ringing. The phase stability requirements of the TWT will therefore force regulation of the grid pulse top. Active circuitry must be designed to perform pulse top clipping and regulating functions and negative bias clamp functions.

Existing, proven circuit designs will be used where possible to minimize design time. The PNP transformer drive circuitry, the pulse top clipper regulator, the TWT bias fault circuitry and the TWT filament fault circuitry all as designed for the AN/TPQ-36 system can be used with very minor modifications.

FLOATING DECK FUNCTIONS

Three different devices for primary drive circuits are under investigation; the PNP transistor, the NPN transistor and the gate turn-off (GTO) SCR. Preliminary circuit designs will be used to determine the optimum performance and most economical configuration.

The pulse top clipper regulator will be in the form of a closed control loop that both clips the oscillations on the modulator transformer secondary and controls the level of the TWT grid pulse across the width of the pulse.

Since interpulse negative grid voltage must only maintain the TWT in the off state and is not otherwise critical, the bias supply may be an unregulated transformer-rectifier power supply.

The clamp supply clamps the negative overshoot from the modulator transformer to a level within the rating of the TWT.

One secondary of the power isolation transformer provides power for the TWT heater regulator. The heater regulator then provides stable power at 8V and 10A to the TWT filament. The voltage from the other secondary of the power isolation transformer is rectified and filtered and used to supply regulated 30 Vdc to 80 kHz inverters which in turn provide power to the various circuit components on the floating deck.

The TWT filament fault circuit and the TWT grid bias fault circuit provide optical signals through fiber optic couplers from the -42 kV level to transmitter control unit (TCU) interfaces at ground level. If the TWT filament voltage drifts either high or low, the "heater OK" signal to the TCU is removed and system operation is terminated. If the TWT grid bias voltage drifts above a preset value, the "bias OK" signal to the TCU is removed and system operation is terminated.

PROGRAM EXPENDITURES

Through 31 May 1977
423 hours
$8800.00

DESIGN REQUIREMENT OUTLINE

I. DRIVERS

a. NPN

b. PNP

c. GTO SCR

II. MODULATOR TRANSFORMER

a. IN/OUT Volt Levels

b. Driving PNT Impedance (rise time)

c. Size, Weight

III. PULSE TOP CLIPPER

a. Amplifier

b. Control Element (Transistor)

c. Voltage Shifters (Zeners)

d. Input Circuits (Sensors)

IV. BIAS SUPPLY

a. Bias for Mod Transformer

b. Negative Clamp

V. INSTRUMENTATION

a. Filament Fault

b. Bias Fault

VI. POWER SUPPLIES

a. TWT Heater

b. 30 Vdc

c. 80 kHz Inverters

MODULATOR PERFORMANCE CHARACTERISTICS

Parameter	Symbol	Design Goal
Grid pulse rise time	t_r	$< 1\ \mu sec$
Grid pulse fall time	t_f	$< 1\ \mu sec$
Minimum Pulse width	Tw	$1\ \mu sec$
Maximum Pulse width	Tw	$10\ \mu sec$
Maximum duty cycle	D_{max}	5%
Pulse top overshoot	V_{pk}	10%
Pulse top Stability	ΔE	0.0058% RMS max

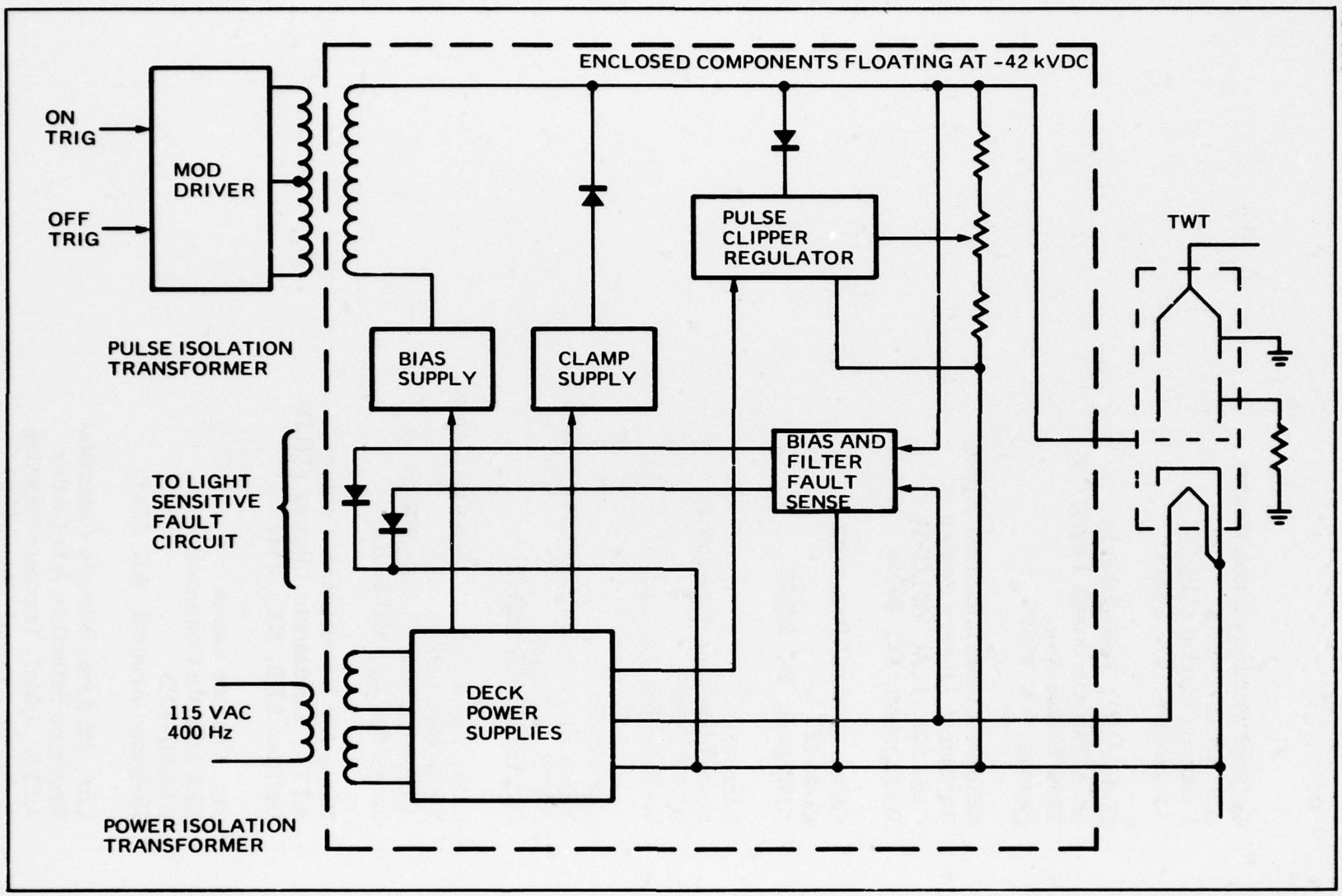

Figure 1. Floating Deck Block Diagram

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